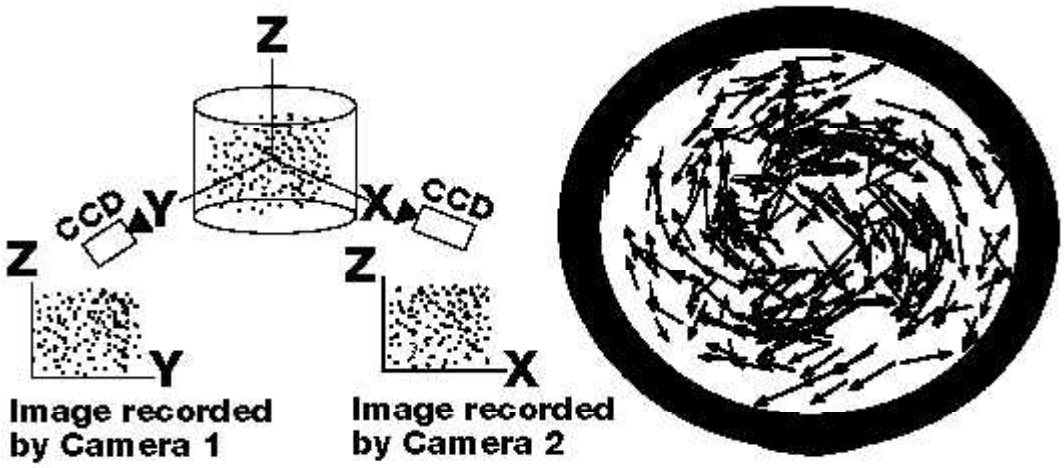
Stereo Imaging Velocimetry

Stereo imaging velocimetry (SIV) will permit the collection of quantitative, three-dimensional flow data from any optically transparent fluid that can be seeded with tracer particles. This includes such diverse experiments as the study of multiphase flow, bubble nucleation and migration, pool combustion, and crystal growth. This technique will be useful to the microgravity science community as our investigations of fluid behavior in reduced-gravity environments enhance our knowledge of heat transfer, surface tension, concentration-gradient-driven anomalies, and residual effects from g-jitter.

In its proposed configuration, the NASA Lewis Research Center's Stereo Imaging Velocimeter will consist of at least two charged coupled device (CCD) cameras, oriented at some relative angle with respect to each other. The cameras will observe a fluid experiment that has been seeded with tracer particles that are neutrally buoyant to permit accurate flow tracking. Except for the tracer particles, this measurement technique will be nonintrusive. Velocity accuracies will be on the order of 1 to 5 percent of full field. Each camera will make a two-dimensional record of the motion of the seed particles in the observation volume. Three-dimensional data will be obtained by computationally combining the two-dimensional information.



Left: Fluid experiment seeded with tracer particles. Right: SIV three-dimensional velocity vectors.

Stereo imaging velocimetry subdivides into several problems:

- Camera calibration
- Centroid determination with overlap decomposition
- Particle tracking
- Stereo matching
- User interface

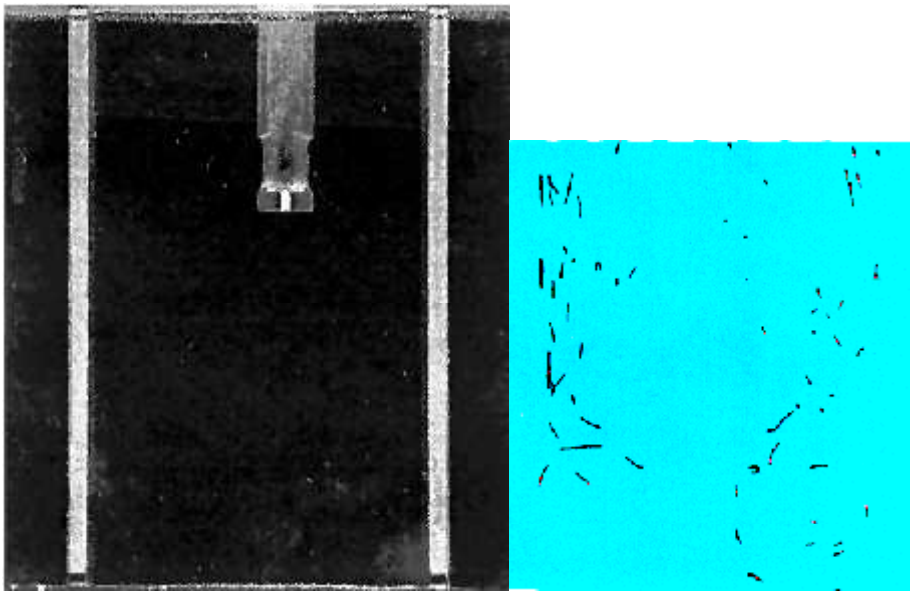
- Testing and error analysis

Benefits

- Stereo imaging velocimetry provides a diagnostic tool for quantitative and qualitative characterization of fluid flows.
- Stereo imaging velocimetry permits direct comparison between computed and experimentally measured three-dimensional flows.
- A PC-based stereo imaging velocimetry applications package is available for incorporation into fluid experiments.

Technology Transfer Highlight

LTV Steel company has requested Lewis' assistance in measuring velocities and flow patterns in a scaled-water model of a submerged entry nozzle and mold of a continuous casting machine. Velocity measurement is being pursued in an attempt to better understand the effects of the submerged entry nozzle design, throughput, depth, and mold width. LTV's ultimate goal is to develop new nozzle designs and casting practices to optimize flow in the mold and reduce defects in as-cast slabs.



Continuous casting model showing raw vectors (left) and SIV vectors (right).

SIV will give LTV advantages over previous qualitative analyses of mold flow (dye injection and video taping). It will provide vector maps of the mold flow which show the direction and magnitude of the flow; these parameters have never been seen with dye injection. In addition, SIV-generated flow-field data will provide more data points for verification and for mathematical models.